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REVISION OF THE HIGH SCHOOL MATHEMATICS CURRICULUM

Curriculum Branch, Department of Education - February, 1970

INTRODUCTION

The proposed revision of the mathematics programs in the senior high schools has caused concern among many teachers, principals, guidance counselors and supervisors. The following information is designed to answer a number of the questions raised. The Curriculum Branch wishes to acknowledge the efforts of many curriculum committees over the past few years who were responsible for developing many of the ideas in this statement. A special acknowledgement goes to Mr. Carl Daneliuk, Mathematics Supervisor, Edmonton Public School Board, who organized many of the ideas into an article which will shortly be published in an issue of the M.C.A.T.A. Newsletter. Much of the material in this statement is drawn directly from this article.

BACKGROUND

Five years ago, two new series of mathematics courses reflecting recent thinking in mathematics curriculum were introduced in the junior and senior high schools. Each subsequent year after the first year one more course was introduced at each level until both series were completed; namely, a new series for grades seven, eight and nine and a new series for Mathematics 10, 20 and 30.

The introduction of the new courses into the junior and senior high school curriculum precipitated the following problems:

1 The vocational mathematics streams, Mathematics 12, 22 and 32 and Mathematics 11 and 21, became isolated because of their traditional nature and transfer from the vocational streams to the new Mathematics 10, 20, 30 stream became extraordinarily difficult.

2 For a variety of reasons, of which the aspirations of many students toward the universities and the deductive nature of Mathematics 10, 20, 30 are paramount, school systems began to experiment with a four year mathematics matriculation stream (not too successfully, it should be added).

3 The proliferation of mathematics courses in the high school (some high schools offered fourteen courses) was beginning to cause many problems of articulation between (a) high schools, (b) high schools and the external agencies, and (c) Alberta and other provinces, as well as problems of communication between counselors, students and parents.

4 The arrival of grade nine students at the high school with three years' experience in revised mathematics programs increased the problem of articulation.

In addition to the above problems, another very significant fact came to light when the students in the high level technologies at the Institutes of Technology were analyzed: students who entered and succeeded came, with few exceptions, from those who first attempted the matriculation mathematics program. Because Mathematics 12, 22, 32 was designed so that each course might meet the needs

of students who might proceed directly into apprenticeship or the world of work, as well as those who wished to proceed to further courses in the sequence, articulation problems in the sequence were present from the time the program was introduced.

Two possibilities were available to revision committees: (1) modify the curriculum within its present structure, or (2) create a new curriculum based on a different rationale. The committees chose the latter of the two possibilities.

RATIONALE

The rationale for the revised curriculum is presented in the form of propositions. A general introductory statement precedes each proposition.

Psychological considerations and the experience of high school teachers of mathematics contributed to the formulation of the first proposition. Although the first proposition may appear simplistic, indeed, self-evident, this proposition is the basis of this rationale. Subsequent propositions, objectives and content firmly rest on the foundation established by the first proposition.

Proposition I: A student should enrol into a mathematics program that is consonant with his ability in mathematics.

On the basis of the first proposition, ideally, a one-to-one correspondence would have to exist between the number of students and the number of mathematics streams. Operationally, it was obvious that the one-to-one correspondence was not feasible and hence a crucial decision as to the number of streams had to be made. Although the mathematical abilities of the students are a continuum, the experience of the high schools who had developed four year matriculation programs and the experience of the teachers of mathematics suggested that the continuum could realistically be partitioned into three subsets of ability.

Proposition II: Three streams of mathematics should be developed for the high school.

During the last ten years most of the mathematics textbooks were written with a deductive approach. Teachers of mathematics have known for some time that a sizable number of students can function quite competently at the inductive level but these same students operate with considerable difficulty at the deductive level. Also, teacher experience revealed that students who could not function competently at either the inductive and deductive levels could demonstrate mathematical gains through the application of simple mathematics to the everyday problems in the world of work and leisure. The different levels of abstraction in mathematics led to the third proposition.

Proposition III: One stream of mathematics should emphasize the deductive approach, the second stream should emphasize the inductive approach, and the third stream should emphasize the application of simple mathematics to the everyday problems of the world of work and leisure.

In the past the universities prescribed the matriculation mathematics as the entrance requirement to almost all faculties. Although recently there has been some relaxation of the entrance requirements, some departments in the Social Sciences faculties still request students to present Mathematics 30. A desirable property of the inductive stream would be the inclusion of content that would not only meet the requirements of the Institutes of Technology but would be an eminently suitable alternative to Mathematics 30 as an entrance requirement to some university faculties.

Proposition IV: The universities be approached for the purpose of seeking acceptance by the third course of the inductive stream as an acceptable non-departmental entrance requirement to a number of university faculties.

On the strength of the four propositions a three stream curriculum in mathematics was devised: (1) Mathematics 10, 20, 30, 31, (2) Mathematics 13, 23, 33, and (3) Mathematics 15, 25.

CHARACTERISTICS OF THE THREE STREAMS

Teachers are reasonably familiar with the Mathematics 10, 20, 30, 31 and Mathematics 15, 25 streams and hence only a brief sketch will be provided. Because the Mathematics 13, 23, 33 stream is a new creature, considerable expansion on the characteristics, objectives and outline of content will be given. It should be noted that while the discussion below tends to emphasize the future goals of graduates, a significant objective of each stream is to provide opportunities for mathematical experiences which contribute to the objectives of general education. Figure 1, page 6, summarizes the essential characteristics of the revised curriculum. While the figure does not indicate possibilities for students to transfer from one program to another, many such possibilities exist and should be considered whenever a student, his parents or the professional staff of a school feel the needs of the student are best met in another program. In this connection, it should be noted that while the Senior High School Handbook indicates prerequisites for certain programs, much responsibility is given to the principal to waive these when the need arises.

Mathematics 10, 20, 30

Other than providing for better articulation with the junior high school and the inclusion of basic trigonometry in the sequence, no substantial changes are contemplated in this stream (approximately 40 - 60% of the grade ten population). The deductive approach will be emphasized and graduates can proceed to the Physical Science faculties at the universities and to the Institutes of Technology.

Mathematics 31

Although no final decision has been reached on the fate of Mathematics 31, the expectation is for the course to remain much as it is presently: multiple half-year courses with various combinations available to each high school.

Mathematics 15, 25

This two year sequence is designed for students who have experienced difficulty in mathematics. The programs are designed so that students experience success and satisfaction rather than failure and frustration. Although textbooks will be recommended it is expected that teachers will modify the course to meet the needs and interests of the students. It is anticipated that 15 - 25% of the population should enrol in the Mathematics 15 course.

Mathematics 13, 23, 33

This stream of mathematics will emphasize the inductive approach. Approximately 25 - 35% of the grade ten population should enrol in Mathematics 13. Graduates of this stream might enrol in the Institutes of Technology and some faculties of the universities (hopefully, they will be able to

use Mathematics 33 as one of the five required entrance courses) as well as proceed to community colleges or the world of work.

ome of the general characteristics of the Mathematics 13, 23, 33 stream are the following:

1. The material should not be as rigorous as the matriculation Mathematics 10, 20, 30, 31 sequence.
2. The approach would be inductive rather than deductive for the main part.
3. Most exercises should require only relatively simple solutions, though more demanding exercises might be classified as "C" exercises.
4. Exercises should not anticipate later concepts to be taught.
5. Problems should be drawn from all fields - technologies, physical sciences, social sciences and the business world.

ore specifically, the stated objectives of this stream are the following:

1. To enable students to experience success in their study of mathematical principles
2. To assist the student in the learning process by developing mathematical concepts by means of an inductive approach.
3. To use applications from various areas such as mensuration, science, and the real world, for the purpose of reinforcing concepts.
4. To develop powers of analyzing problems and of presenting their solution in a clear manner.
5. To develop and maintain an understanding of the operations and concepts of mathematics by using an essential core supplemented by exploratory topics.
6. To develop and maintain skill in mathematical operations by these means.

e content of the inductive stream was deliberately structured so that the mathematics is not, and large, sequential within the topics of the course; it is sequential between courses. This ould become clear from the perusal of the following brief description of the tentative outline the content:

Mathematics 13

1	Introduction to Descriptive Statistics
2	Geometry - inductive developments of fundamental relationships
3	Numerical Trigonometry (sin, cos, and tan)
4	Polynomials - fundamental operations and factoring
5	Rational Expressions
6	Integral Exponents, Scientific Notation
7	Real Number Plane - graphs of linear equation and inequation
8	Relations, Formula, Variation

Mathematics 23

1	Real Numbers
2	Exponents - fractions, radicals, logarithms
3	Slide Rule
4	Quadratic Equations - solution and problems
5	Equation Systems - linear programming - flow charting
6	Geometry - circle - coordinate
7	Trigonometry - reciprocal functions - graphs of sine and cosine - any angle
8	Probability

Mathematics 33

1	Function Concept - linear and quadratic - exponential and logarithmic
2	Trigonometry - sine and cosine law - vectors
3	Permutations and Combinations
4	Descriptive Statistics - histograms - quartiles, percentiles - measures of variability - normal distribution

FIGURE 1: REVISED HIGH SCHOOL MATHEMATICS CURRICULUM

ESTIMATED PROPORTION OF GRADE TEN STUDENTS	GRADE X	GRADE XI	GRADE XII	
40 - 60%	MATH 10	MATH 20	MATH 30	UNIVERSITY INSTITUTES
			MATH 31	
	INDUCTIVE APPROACH EMPHASIZED			
25 - 35%	MATH 13	MATH 23	MATH 33	UNIVERSITY (non-departmental) INSTITUTES APPRENTICESHIP
	INDUCTIVE APPROACH EMPHASIZED			
15 - 25%	MATH 15	MATH 25	NO MATH	WORLD OF WORK APPRENTICESHIP COMMUNITY COLLEGES INSTITUTES
	PRACTICAL APPROACH EMPHASIZED			

SUMMARY

The main features of the revised high school curriculum may be summarized as the following: (1) enrolment into a stream is based on mathematical ability rather than program. (2) three streams of mathematics, (3) differentiation of approach in each stream - deductive, inductive and application, (4) intention of making Mathematics 33 a non-departmental subject for entrance into some faculties at the universities, and (5) non-vocational nature of the curriculum.

INTRODUCTION OF THE PROGRAM

The following points should be noted:

1 Mathematics 13 and 23 will be introduced in September 1970 as announced in the December Curriculum Bulletin. Course outlines will be available from the Curriculum Branch May 1. It is not expected that these will differ substantially from the tentative course outline in this paper.

2 It is planned to introduce Mathematics 33 in September 1971.

3 There will be single textbooks recommended for Mathematics 13 and 23. These will be entitled PRINCIPLES OF MATHEMATICS I and II respectively and will be published by Holt, Rinehart and Winston of Canada Ltd. Because no available books met the needs of the courses, these books are being developed especially for the program. They are now in preparation and present indications are they will be available in the School Book Branch after June 15, 1970, however, experience has shown that production difficulties often postpone the date of availability. Interim editions have been used on an experimental basis; however, no additional copies of the interim edition are available.

4 Revised course outlines and different textbooks for Mathematics 10 and 20 are being recommended to the Secondary School Curriculum Board for introduction in September 1970. Final decisions will be announced in a Curriculum Bulletin in late March or early April.

5 It is expected that a curriculum guide for Mathematics 10, 20, 13. 23 will be prepared. The publication will likely not be available until July or August.

6 Present courses in mathematics other than the streams identified in this paper will be phased out at the provincial level according to the schedule below:

Mathematics 11 - 1970	Mathematics 21 - 1971	
Mathematics 12, 14 - 1971	Mathematics 22 - 1972	Mathematics 33 - 1973

7 While both Mathematics 13 and 23 and possibly revised programs in Mathematics 10 and 20 are being made available in September 1970 to meet special needs of some semester schools, it is expected that many schools will introduce these programs on a one-per-year basis.

8 It is recognized that the number of streams available in small high schools will be limited by the scope of the total program, as has been the case in the past.

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